

CLAIMS

1. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of measurement; a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received; and a distance display for displaying the distance to the above-mentioned object of measurement,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to distance when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to distance by adding up the above-mentioned frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times; a distance determiner for determining as the distance to the above-mentioned object of measurement the point when the total count in the above-mentioned frequency distribution table exceeds a specific threshold; and a distance selector for selecting (a) specific distance(s) from among a plurality of distances when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of

measurement, and displaying the selected distance on the above-mentioned distance display.

2. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of measurement; a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received; and a distance display for displaying the distance to the above-mentioned object of measurement,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to elapsed time when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to elapsed time by adding up the above-mentioned frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times; a distance determiner for determining as the distance to the above-mentioned object of measurement the elapsed time, converted to distance, at which the total count in the above-mentioned frequency distribution table exceeds a specific threshold; and a distance selector for selecting (a) specific distance(s) from among a plurality of distances when the above-mentioned distance determiner determines a plurality of distances to the

above-mentioned object of measurement, and displaying the selected distance on the above-mentioned distance display.

3. The ranging apparatus according to Claim 1 or 2, wherein when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of measurement, the above-mentioned distance selector selects the longest distance and displays it on the above-mentioned distance display.

4. The ranging apparatus according to Claim 1 or 2, wherein when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of measurement, the above-mentioned distance selector selects the shortest distance and displays it on the above-mentioned distance display.

5. The ranging apparatus according to Claim 1 or 2, wherein when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of measurement, the above-mentioned distance selector selects the n -th (where n is a positive integer) longest distance from among the above-mentioned plurality of distances and displays it on the above-mentioned distance display.

6. The ranging apparatus according to Claim 1 or 2, wherein the above-mentioned distance selector is constructed so that the selection conditions are set by

external operation by the user, and when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of measurement, a specific distance is selected on the basis of the above-mentioned selection conditions set in the above-mentioned distance selector, and displayed on the above-mentioned distance display.

7. The ranging apparatus according to Claim 1 or 2, wherein when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of measurement, the above-mentioned distance selector selects the distance according to a usage condition, etc., and displays it on the above-mentioned distance display.

8. The ranging apparatus according to Claim 7, wherein the focal point of a finder for sighting the above-mentioned object of measurement is used as the above-mentioned usage condition, the above-mentioned distance selector selects a long distance when the above-mentioned focal point is far, and the above-mentioned distance selector selects a short distance when the above-mentioned focal point is near.

9. The ranging apparatus according to Claim 7, wherein the weather at the time of ranging is used as the above-mentioned usage condition, and the above-

mentioned distance selector selects a long distance when measuring the distance to the above-mentioned target in the rain or snow.

10. The ranging apparatus according to any of Claims 7 to 9, wherein the above-mentioned usage conditions, etc., can be switched and set by the user.

11. The ranging apparatus according to Claim 1 or 2, wherein when the above-mentioned distance determiner determines a plurality of distances to the above-mentioned object of measurement, the above-mentioned distance selector determines that there are a plurality of the above-mentioned objects of measurement, and displays a plurality of distances on the above-mentioned distance display.

12. The ranging apparatus according to Claim 11, wherein all of the above-mentioned plurality of distances are displayed at once on the above-mentioned distance display.

13. The ranging apparatus according to Claim 11, wherein the above-mentioned plurality of distances are displayed one after another on the above-mentioned distance display.

14. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to distance is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to distance is produced by adding up the frequencies counted in all of the above-mentioned measurement light emissions carried out a specific number of times,

the point when the total count in the above-mentioned frequency distribution table exceeds a specific threshold is determined as the distance to the above-mentioned object of measurement,

the distance to the above-mentioned object of measurement thus determined is displayed, and

when a plurality of distances to the above-mentioned object of measurement are determined, a specific distance is selected from among the above-mentioned plurality of distances and displayed.

15. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of

measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to elapsed time is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to elapsed time is produced by adding up the frequencies counted in all of the above-mentioned measurement light emissions carried out a specific number of times,

the distance is found from the elapsed time at which the total count in the above-mentioned frequency distribution table exceeds a specific threshold, this distance is determined as the distance to the above-mentioned object of measurement,

the distance to the above-mentioned object of measurement thus determined is displayed, and

when a plurality of distances to the above-mentioned object of measurement are determined, a specific distance is selected from among the above-mentioned plurality of distances and displayed.

16. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of

measurement; and a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to distance when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to distance by adding up the frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times; and a distance determiner for determining as the distance to the above-mentioned object of measurement the point when the total count in the above-mentioned frequency distribution table produced by the above-mentioned table production component exceeds a specific threshold, and

the above-mentioned threshold is varied and set according to distance in the above-mentioned frequency distribution table.

17. The ranging apparatus according to Claim 16, wherein the above-mentioned threshold is set so as to decrease as the distance increases in the above-mentioned frequency distribution table.

18. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light

receiver for receiving light reflected back from the above-mentioned object of measurement; and a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to elapsed time when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to elapsed time by adding up the frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times; and a distance determiner for determining as the distance to the above-mentioned object of measurement the elapsed time, converted to distance, at which the total count in the above-mentioned frequency distribution table produced by the above-mentioned table production component exceeds a specific threshold, and

the above-mentioned threshold is varied and set according to elapsed time in the above-mentioned frequency distribution table.

19. The ranging apparatus according to Claim 18, wherein the above-mentioned threshold is set so as to decrease as the elapsed time increases in the above-mentioned frequency distribution table.

20. The ranging apparatus according to any of Claims 16 to 19, wherein the intensity of the above-mentioned reflected light is used as the above-mentioned specific condition, and the above-mentioned counter performs a frequency count when the intensity of the above-mentioned reflected light exceeds a specific intensity threshold.

21. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to distance is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to distance is produced by adding up the frequencies counted in all of the above-mentioned measurement light emissions carried out a specific number of times, and

the point when the total count in the above-mentioned frequency distribution table exceeds a threshold set so as to vary according to distance is determined as the distance to the above-mentioned object of measurement.

22. The ranging method according to Claim 21, wherein the above-mentioned threshold is set so as to decrease as the distance increases in the above-mentioned frequency distribution table.

23. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to elapsed time is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to elapsed time is produced by adding up the frequencies counted in all of the above-mentioned measurement light emissions carried out a specific number of times,

the distance is found from the elapsed time at which the total count in the above-mentioned frequency distribution table exceeds a threshold set so as to vary according to elapsed time, and this distance is determined as the distance to the above-mentioned object of measurement.

24. The ranging method according to Claim 23, wherein the above-mentioned threshold is set so as to decrease as the elapsed time increases in the above-mentioned frequency distribution table.

25. The ranging method according to any of Claims 21 to 24, wherein the above-mentioned specific condition is that a frequency count is performed when the intensity of the above-mentioned reflected light exceeds a specific intensity threshold.

26. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of measurement; and a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to distance when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to distance by adding up the frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times, and by performing moving averaging in which

the frequency at each distance added up in this manner is replaced with an average frequency at a plurality of distances including the distance itself and those before and after that distance; and a distance determiner for determining as the distance to the above-mentioned object of measurement the point when the total count in the above-mentioned frequency distribution table exceeds a specific threshold.

27. The ranging apparatus according to Claim 26, wherein the above-mentioned number of distances for which an average is calculated in the above-mentioned moving averaging can be variably set.

28. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of measurement; and a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to elapsed time when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to elapsed time by adding up the frequencies with respect to the above-mentioned measurement light repeatedly

emitted a specific number of times, and by performing moving averaging in which the frequency at each elapsed time added up in this manner is replaced with an average frequency at a plurality of elapsed times including the elapsed time itself and those before and after that elapsed time; and a distance determiner for determining as the distance to the above-mentioned object of measurement the elapsed time, converted as distance, at which the total count in the above-mentioned frequency distribution table exceeds a specific threshold.

29. The ranging apparatus according to Claim 28, wherein the above-mentioned number of elapsed times for which an average frequency is calculated in the above-mentioned moving averaging can be variably set.

30. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to distance is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to distance is produced by adding up the frequencies counted in all of the above-mentioned measurement light

emissions carried out a specific number of times, and by performing moving averaging in which the frequency at each distance added up in this manner is replaced with an average frequency at a plurality of distances including the distance itself and those before and after that distance, and

the point when the total count in the above-mentioned frequency distribution table exceeds a specific threshold is determined as the distance to the above-mentioned object of measurement.

31. The ranging method according to Claim 30, wherein the above-mentioned number of distances for which an average is calculated in the above-mentioned moving averaging is varied.

32. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to elapsed time is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to elapsed time is produced by adding up the frequencies counted in all of the above-mentioned measurement light

emissions carried out a specific number of times, and by performing moving averaging in which the frequency at each elapsed time added up in this manner is replaced with an average frequency at a plurality of elapsed times including the elapsed time itself and those before and after that elapsed time,

the distance is found from the elapsed time at which the total count in the above-mentioned frequency distribution table exceeds a specific threshold, and this distance is determined as the distance to the above-mentioned object of measurement.

33. The ranging method according to Claim 32, wherein the above-mentioned number of elapsed times for which an average is calculated in the above-mentioned moving averaging is varied.

34. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of measurement; and a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to distance when the above-mentioned

reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to distance by adding up the frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times; and a distance determiner for determining as the distance to the above-mentioned object of measurement the point when the total count in the above-mentioned frequency distribution table produced by the above-mentioned table production component exceeds a specific threshold, and

a plurality of types of the above-mentioned threshold are set.

35. A ranging apparatus comprising: a measurement light emitter for emitting pulsed measurement light toward an object of measurement; a reflected light receiver for receiving light reflected back from the above-mentioned object of measurement; and a distance computer for finding the distance to the above-mentioned object of measurement on the basis of the elapsed time from when the above-mentioned measurement light is emitted until the above-mentioned reflected light is received,

wherein the above-mentioned distance computer comprises: a counter for counting the frequency corresponding to elapsed time when the above-mentioned reflected light satisfies a specific condition; a table production component for producing a frequency distribution table corresponding to elapsed time by adding up the frequencies with respect to the above-mentioned measurement light repeatedly emitted a specific number of times; and a distance determiner for determining as

the distance to the above-mentioned object of measurement the elapsed time, converted to distance, at which the total count in the above-mentioned frequency distribution table produced by the above-mentioned table production component exceeds a specific threshold, and

a plurality of types of the above-mentioned threshold are set.

36. The ranging apparatus according to Claim 34 or 35, wherein the above-mentioned distance computer has a threshold selector for selecting and using the plurality of types of threshold according to the determination of the above-mentioned distance determiner.

37. The ranging apparatus according to Claim 36, wherein when none of the total counts in the frequency distribution table exceed a threshold selected by the above-mentioned threshold selector, the above-mentioned threshold selector switches to a threshold with a lower value than the above-mentioned selected threshold.

38. The ranging apparatus according to Claim 36, wherein when there are a plurality of total counts in the above-mentioned frequency distribution table that exceed a threshold selected by the above-mentioned threshold selector, the above-mentioned threshold selector switches to a threshold with a higher value than the above-mentioned selected threshold.

39. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to distance is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to distance is produced by adding up the frequencies counted in all of the above-mentioned measurement light emissions carried out a specific number of times,

the point when the total count in the above-mentioned frequency distribution table exceeds a specific threshold is determined as the distance to the above-mentioned object of measurement,

a plurality of types of the above-mentioned threshold are set, and the above-mentioned plurality of types of threshold are selected and used.

40. A ranging method in which pulsed measurement light is emitted toward an object of measurement, and the distance to the above-mentioned object of measurement is determined on the basis of the elapsed time until the light reflected back from the above-mentioned object of measurement is received,

wherein the above-mentioned pulsed measurement light is repeatedly emitted toward the object of measurement,

a frequency count corresponding to elapsed time is performed when the above-mentioned reflected light for each emission satisfies a specific condition,

a frequency distribution table corresponding to elapsed time is produced by adding up the frequencies counted in all of the above-mentioned measurement light emissions carried out a specific number of times,

the distance is found from the elapsed time at which the total count in the above-mentioned frequency distribution table exceeds a specific threshold, this distance is determined as the distance to the above-mentioned object of measurement,

a plurality of types of the above-mentioned threshold are set, and the above-mentioned plurality of types of threshold are selected and used.

41. The ranging method according to Claim 39 or 40, wherein a specific threshold is selected from among the above-mentioned plurality of types of threshold, and when none of the total counts in the above-mentioned frequency distribution table exceed the above-mentioned specific threshold, the above-mentioned threshold is switched to a threshold with a lower value.

42. The ranging method according to Claim 39 or 40, wherein a specific threshold is selected from among the above-mentioned plurality of types of threshold, and

when there are a plurality total counts in the above-mentioned frequency distribution table that exceed the above-mentioned specific threshold, the above-mentioned threshold is switched to a threshold with a higher value.

43. An opto-electric conversion circuit in which an avalanche photodiode is used, wherein this opto-electric conversion circuit comprises: a reverse bias voltage regulating component for regulating the reverse bias voltage applied to the above-mentioned avalanche photodiode; a current measurement component for measuring the current flowing to the above-mentioned avalanche photodiode; a reference reverse bias voltage detecting component for regulating the above-mentioned reverse bias voltage and detecting the reverse bias voltage at which a specific current flows to the above-mentioned avalanche photodiode (reference reverse bias voltage); and a reverse bias voltage setting component for adjusting the reverse bias voltage applied to the above-mentioned avalanche photodiode during opto-electric conversion to a voltage obtained by multiplying the above-mentioned detected reference reverse bias voltage by a specific ratio.

44. A laser ranging apparatus which measures the distance to an object of measurement by radiating laser light toward the object of measurement and measuring the time differential between the point when the laser light is radiated and the point when the laser light reflected back from the object of measurement is received, wherein the circuit for detecting the receipt of laser light reflected back

from the object of measurement has the opto-electric conversion circuit according to Claim 43.

45. The ranging apparatus according to Claim 44, wherein the above-mentioned reverse bias voltage setting component is actuated before the start of every measurement or every time the power to the apparatus is switched on.